Electron-Capture Delayed Fission of ^{242}Es

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Electron-capture delayed fission (ECDF) is a decay mode in which the parent nucleus undergoes electron-capture (EC) decay, populating excited states in the daughter nucleus which then fission. This decay mode allows us to study fission properties of neutron-deficient actinides that would normally have spontaneous fission branches too small for study. Our group has found delayed fission branches in the americium, neptunium and berkelium regions where the electron-capture Q-value (Q_{EC}) approaches the height of the fission barrier. ^{242}Es was originally chosen for study because its Q_{EC} of 5.6 MeV was at least 1 MeV greater than in other systems previously studied. Previous work has shown that the probability of delayed fission (P_{DF}) increases with increasing Q_{EC}.[1]

^{242}Es was produced at the 88-Inch Cyclotron via the ^{233}U(^{14}N,5n)^{242}Es reaction using an 87-MeV (on target) ^{14}N beam. Reaction products were swept from the target chamber using a He/KCl gas-jet, and were transported via a capillary to our rotating wheel detection system. Collected samples were stepped every 20 seconds between six pairs of solid state particle detectors in order to measure alpha particles and coincident fission fragments.

A total of 48 pairs of coincident fission fragments were detected with a half-life of 21±4 sec. This is consistent with previously reported values.[2] The EC branch of ^{242}Es is not known, but was estimated to be 60% based on level assignments and cross section predictions for this region. A production cross section on the order of 30 nb was measured based on the production of ^{242}Es and ^{242}Cf. We also measured a P_{DF} of 0.005, which is consistent with the relationship between P_{DF} and Q_{EC} shown in Ref. 1. Figs. 1 and 2 show the mass-yield and total kinetic energy (TKE) distributions for fission of ^{242}Cf. We measured a pre-neutron average TKE of 183±18 MeV, which agrees with the predictions of 194 MeV and 191 MeV made by Unik and Viola respectively.[3,4]

Footnotes and References

1. S.A. Kreek et al., Phys. Rev. C **50**, 2288 (1994).
2. V. Ninov et al., Z. Phys. A **356**(1), 11 (1996).
3. J.P. Unik et al., *Proceedings of the Third International IAEA Symposium on the Physics and Chemistry of Fission*, Rochester, 1973 (IAEA, Vienna, 1974), Vol. II, p.33.
4. V.E. Viola et al., Phys. Rev. C **31**, 1550 (1985).

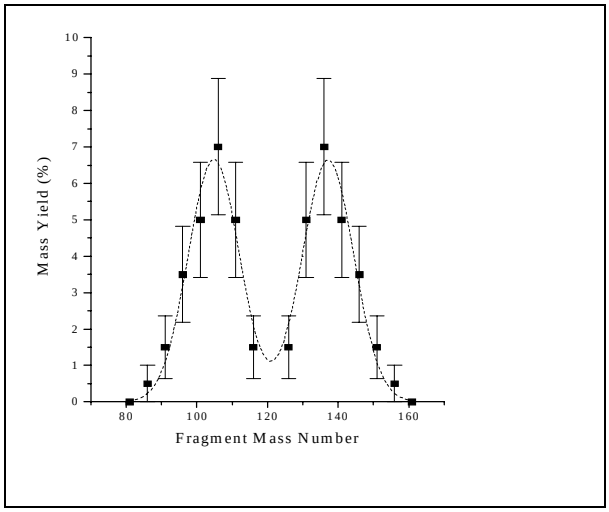

Fig. 1. Mass-yield distribution for fission of ^{242}Cf.

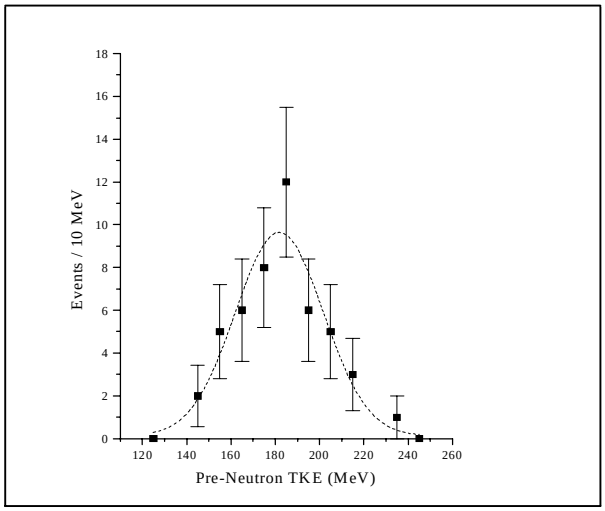

Fig. 2. TKE distribution for fission of ^{242}Cf.